IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Wen Tong et al.
Serial No. 10/792,127
Filed: 03/04/2004

Examiner: Burd, Kevin Michael
Art Unit: 2611

For: **COMMUNICATION CHANNEL OPTIMIZATION SYSTEMS AND METHODS IN MULTI-USER COMMUNICATION SYSTEMS**

Mail Stop Amendment
Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Sir:

An **APPEAL BRIEF** is filed herewith. Appellant authorizes the Director to charge Deposit Account 14-1315 in the amount of $540.00 as required by 37 C.F.R. § 1.17(c). Applicant also encloses a payment of $1110.00 for a three-month extension of time and requests that this be considered a petition therfor. If any additional fees are required in association with this appeal brief, the Director is hereby authorized to charge them to Deposit Account 14-1315, and consider this a petition therefor.

APPEAL BRIEF

(1) REAL PARTY IN INTEREST

The real party in interest is the assignee of record, i.e., Nortel Networks Limited of 2351 Boulevard Alfred-Nobel, St. Laurent, Quebec Canada H4S 2A9, which is wholly owned by Nortel Networks Corporation, a Canadian corporation.

(2) RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences to the best of Appellant's knowledge.

(3) STATUS OF CLAIMS

Claims 1, 29-31, and 56 were previously cancelled.

Claim 5 was allowed.

Claims 2-4, 6-8, 10-13, 15-28, 32-43, 48-55, 57-60 were rejected with the rejection made final on October 13, 2009.

Claims 9, 14, and 44-47 have been deemed to contain allowable subject matter.

Claims 2-4, 6-28, 32-55, and 57-60 are pending and are the subject of this appeal.

(4) STATUS OF AMENDMENTS

All amendments have been entered to the best of Appellant's knowledge. No amendments have been filed after the Final Office Action mailed October 13, 2009.

(5) SUMMARY OF CLAIMED SUBJECT MATTER

In the following summary, Appellant has noted where in the Specification certain subject matter exists. Appellant wishes to point out that these citations are for demonstrative purposes only and that the Specification may include additional discussion of the various elements, citations to which are not pointed out below. Thus, the noted citations are in no way intended to limit the scope of the pending claims.

Independent claim 13 recites a method of processing signals to be transmitted to receivers (such as receivers in antennas 18 in user equipment (UE) 12, Figure 1) on a plurality of communication channels, comprising:

determining pre-coding signal weights based on channel state information associated with the plurality of communication channels to provide proportional power allocation to the signals (Specification, page 2, lines 20-23; page 10, lines 13-20; page 14, lines 6-13, page 15, lines 5-9; page 17, lines 7-16, page 18, lines 8-12; and page 21, lines 5-12; see also Figures 5-7); and

applying the pre-coding signal weights to the signals (Specification, page 2, lines 24; page 3, line 18; page 4, lines 8-9 and 28-30; page 10, lines 13-20; and page 17, lines 7-16; see also Figures 5-7),

wherein the method is implemented at a transmitter (such as transmitter at base transceiver station (BTS) 10 of user equipment (UE) 12, Figure 1) in a multi-user MIMO (Multiple Input Multiple Output) communication system (such as MIMO system, Figures 1-11, see Specification, page 7, lines 4-11) that provides respective $N \times N$ sub-MIMO channels from the transmitter to the receivers, wherein each of the groups of signals comprises N signals (Specification, page 8, lines 6-17; page 13, lines 19-27; and page 14, lines 6-13; see also Figures 5-7),

wherein the signals comprise respective groups of signals to be transmitted to the receivers, wherein determining the pre-coding signal weights further comprises determining the pre-coding signal weights to separate the respective groups of signals (Specification, page 3, lines 5-10; page 13, lines 11-18; and page 20, line 15 through page 21, line 4; see also Figures 5-7), and

wherein determining the pre-coding signal weights comprises determining elements of a pre-coding matrix P such that a combined communication channel matrix $C = HP$ has a form of U $N \times N$ sub-matrices, diagonal elements of which are respective diagonal elements of C, and elements of C outside the $N \times N$ sub-matrices are forced to zero (Specification, page 15, line 5 through page 19, line 2; and page 22, lines 5-11; see also Figures 5-7).

Independent claim 16 recites a method of processing signals to be transmitted to receivers on a plurality of communication channels, comprising:

determining pre-coding signal weights based on channel state information associated with the plurality of communication channels to provide proportional power allocation to the signals (Specification, page 2, lines 20-23; page 10, lines 13-20; page 14, lines 6-13, page 15, lines 5-9, page 17, lines 7-16; page 18, lines 8-12; and page 21, lines 5-12; see also Figures 5-7);

applying the pre-coding signal weights to the signals (Specification, page 2, lines 24; page 3, line 18; page 4, lines 8-9 and 28-30; page 10, lines 13-20; and page 17, lines 7-16; see also Figures 5-7);

transmitting weighted signals to the receivers on the plurality of communication channels (Specification, page 4, lines 1-9; page 10, lines 17-20; and page 22, lines 12-18); and

at each of the receivers:

receiving a subset of the weighted signals over a sub-group of the plurality of communication channels (Specification, page 2, line 28 through page 3, line 1; page 3, lines 18-31; page 8, lines 3-17; page 10, lines 11-17; page 14, lines 7-16; page 18, lines 5-12; page 22, lines 15-18; and page 23, lines 1-7; see also Figures 2 and 5-7); and

decoding the subset of the weighted signals using inverses of the pre-coding signal weights based on the channel state information associated with the sub-group of the plurality of communication channels (Specification, page 3, lines 1-10 and 22-31; page 11, lines 7-14; and page 19, lines 3-14).

Independent claim 17 recites a method comprising:

receiving over a sub-group of a plurality of communication channels a subset of a plurality of signals to which pre-coding signal weights based on channel state information associated with the sub-group of the plurality of communication channels to provide proportional power allocation have been applied (Specification, page 2, line 28 through page 3, line 1; page 3, lines 18-31; page 8, lines 3-17; page 10, lines 11-17; page 14, lines 7-16; page 18, lines 5-12; page 22, lines 15-18; and page 23, lines 1-7; see also Figs 2 and 5-7); and

decoding the subset of the plurality of signals using inverses of the pre-coding signal weights based on the channel state information associated with the sub-group of the plurality of communication channels (Specification, page 3, lines 1-10 and 22-31; page 11, lines 7-14; and page 19, lines 3-14).

Independent claim 32 recites a system for processing signals to be transmitted to receivers on a plurality of communication channels comprising:

an input means for receiving the signals (Specification, page 3, lines 13-14 and 22-27; and page 4, line 22 (input means may include, but are not limited to receivers in antennas 18 in user equipment (UE) 12, Figure 1); and

a processor configured to determine pre-coding signal weights based on channel state information associated with the plurality of communication channels to provide proportional power allocation to the signals, and to apply the pre-coding signal weights to the signals (Specification, page 2, lines 20-23; page 3, lines 14-18 and 27-31; page 4, lines 23-30; page 10, lines 13-20; page 14, lines 6-13 and lines 26-29; page 15, lines 5-9; page 17, lines 7-16; page 18, lines 8-12; and page 21, lines 5-12; see also Figures 5-7),

wherein the system is implemented at a network element of a communication network (Specification, page 4, lines 19 through page 5, line 11), the communication network further comprising a plurality of receivers (such as receivers in antennas 18 in user equipment (UE) 12, Figure 1), each receiver of the plurality of receivers comprising:

an input means (Specification, page 3, lines 13-14 and 22-27; and page 4, line 22 (input means may include, but are not limited to receivers in antennas 18 in user equipment (UE) 12, Figure 1) for receiving a subset of weighted signals over a sub-group of the plurality of communication channels (Specification, page 2, line 28 through page 3, line 1; page 3, lines 18-31; page 8, lines 3-17; page 10, lines 11-17; page 14, lines 7-16; page 18, lines 5-12; page 22, lines 15-18; and page 23, lines 1-7; see also Figs 2 and 5-7); and

a processor configured to decode the subset of weighted signals using inverses of the pre-coding signal weights based on the channel state information associated with the sub-group of the plurality of communication channels (Specification, page 2, lines 20-23; page 3, lines 14-18 and 27-31; page 4, lines 23-30; page 10, lines 13-20; page 14, lines 6-13 and lines 26-29; page 15, lines 5-9; page 17, lines 7-16; page 18, lines 8-12; and page 21, lines 5-12; see also Figures 5-7).

Independent claim 35 recites a system comprising:

an input means (Specification, page 3, lines 13-14 and 22-27; and page 4, line 22 (input means may include, but are not limited to receivers in antennas 18 in user equipment (UE) 12, Figure 1) for receiving over a sub-group of a plurality of communication channels a subset of a plurality of signals to which pre-coding signal weights based on channel state information

associated with the sub-group of the plurality of communication channels to provide proportional power allocation have been applied (Specification, page 2, line 28 through page 3, line 1; page 3, lines 18-31; page 8, lines 3-17; page 10, lines 11-17; page 14, lines 7-16; page 18, lines 5-12; page 22, lines 15-18; and page 23, lines 1-7; see also Figs 2 and 5-7); and

a processor configured to decode the subset of the plurality of signals using inverses of the pre-coding signal weights based on the channel state information associated with the sub-group of the plurality of communication channels (Specification, page 2, lines 20-23; page 3, lines 14-18 and 27-31; page 4, lines 23-30; page 10, lines 13-20, page 14, lines 6-13 and 26-29; page 15, lines 5-9; page 17, lines 7-16; page 18, lines 8-12; and page 21, lines 5-12; see also Figures 5-7).

Independent claim 39 recites a method of processing signals to be concurrently transmitted to receivers over a plurality of communication channels comprising:

determining channel state information for the plurality of communication channels (Specification, page 4, lines 4-5 and 10-12; and page 14, lines 19-20; see also Figures 5-7);

determining a spatial coding matrix comprising a respective set of spatial coding weights for each of the receivers based on the channel state information (Specification, page 5, lines 5-7; page 27, lines 1-11; and page 29, line 7 through page 30, line 6); and

applying the respective set of spatial coding weights in the spatial coding matrix to the signals (Specification, page 4, lines 8-9; and page 29, line 7 through page 30, line 6).

Independent claim 50 recites a method comprising:

determining channel state information for a communication channel between a receiver and a transmitter (Specification, page 4, lines 4-5 and 10-12; and page 14, lines 19-20; see also Figures 5-7);

transmitting the channel state information to the transmitter (Specification, page 4, lines 13-14); and

receiving from the transmitter one of a plurality of demodulation matrices for demodulating subsequently received communication signals to which spatial coding weights comprising respective sets of spatial coding weights for a plurality of receivers have been applied

(Specification, page 4, lines 14-18; page 27, lines 1-11; and page 29, line 7 through page 30, line 6).

Independent claim 52 recites a network element for processing signals to be concurrently transmitted to a plurality of communication terminals in a communication network (Specification, page 4, line 19 through page 5, line 11), comprising:

an input means (Specification, page 3, lines 13-14 and 22-27; and page 4, line 22 (input means may include, but are not limited to receivers in antennas 18 in user equipment (UE) 12, Figure 1) configured to receive the signals (Specification, page 2, line 28 through page 3, line 1; page 3, lines 18-31; page 8, lines 3-17; page 10, lines 11-17; page 14, lines 7-16; page 18, lines 5-12; page 22, lines 15-18; and page 23, lines 1-7; see also Figs 2 and 5-7); and

a processor configured to determine channel state information for each of a plurality of communication channels between the network element and the plurality of communication terminals, to determine a spatial coding matrix comprising a respective set of spatial coding weights for each of the plurality of communication terminals based on the channel state information, and to apply the respective set of spatial coding weights in the spatial coding matrix to the signals (Specification, page 2, lines 20-23; page 3, lines 14-18 and 27-31; page 4, lines 23-30; page 5, lines 5-7; page 10, lines 13-20, page 14, lines 6-13 and 26-29; page 15, lines 5-9; page 17, lines 7-16, page 18, lines 8-12; page 21, lines 5-12; page 27, lines 1-11; and page 29, line 7 through page 30, line 6; see also Figures 5-7).

(6) GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

A. Whether claims 2-4, 6-8, 13, 15-20, 22, 26-28, 32, 34, 35, 38-43, 48-55, and 57-60 were properly rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,873,606 B2 to Agrawal et al. (hereinafter "Agrawal").

B. Whether claims 10-12, 23-25, 33, 36, and 37 were properly rejected under 35 U.S.C. § 103(a) as being unpatentable over Agrawal in view of U.S. Patent Application Publication No. 2005/0053170 to Catreux et al. (hereinafter "Catreux").

C. Whether claim 21 was properly rejected under 35 U.S.C. § 103(a) as being unpatentable over Agrawal in view of U.S. Patent No. 5,828,658 to Ottersten et al. (hereinafter "Ottersten").

(7) ARGUMENT

A. Introduction

The Patent Office has not made the necessary showing that all the elements of the pending claims are found in the prior art with sufficient particularity in order to sustain an anticipation or obviousness rejection. In particular, Agrawal fails to teach or suggest each and every element of independent claim 16. To summarize, in claim 16, the pre-coding signal weights are based on channel state information associated with the plurality of communication channels, and the decoding is done on subsets of the received weighted signals using inverses of the pre-coding signal weights based on the channel state information associated with the sub-group of the plurality of communication channels. Agrawal does not teach this method of coding and decoding, where subsets of weighted signals are decoded using inverses of the pre-coding weights that are based on channel state information of only a sub-group of the communication channels. Agrawal fails to disclose the steps of "receiving **a subset** of the weighted signals over **a sub-group of the plurality of communication channels**" and "decoding **the subset of the weighted signals** using inverses of the pre-coding signal weights **based on the channel state information associated with the sub-group of the plurality of communication channels**," at each of the receivers, as recited in claim 16.

Claim 13 is an independent claim that recites limitations similar to those recited in claim 16 and thus is patentable over Agrawal for at least the same reasons set forth above with respect to claim 16. Moreover, the Patent Office has not pointed with particularity to any portion of Agrawal that discloses "wherein the signals comprise respective groups of signals to be transmitted to the receivers, wherein determining the pre-coding signal weights further comprises determining the pre-coding signal weights to separate the respective groups of signals," as recited in claim 13. Agrawal is silent as to separating the respective groups of signals by determining the pre-coding signal weights. Furthermore, the Patent Office has not pointed with particularity to any portion of Agrawal that discloses "wherein determining the pre-coding signal weights comprises determining elements of a pre-coding matrix P such that a combined communication channel matrix $C = HP$ has a form of U $N \times N$ sub-matrices, diagonal elements of which are respective diagonal elements of C, and elements of C outside the $N \times N$ sub-matrices are forced to zero," as recited in claim 13.

Claim 17 has limitations similar to those recited in claim 16. Independent claims 32 and 35 have similar limitations to those recited in claims 16 and 17. Thus, independent claims 17, 32, and 35 are patentable for at least the same reasons as set forth with respect to claim 16.

With respect to independent claim 39, Agrawal does not teach "determining a spatial coding matrix comprising **a respective set of spatial coding weights for each of the receivers based on the channel state information**" and "applying the respective set of spatial coding weights in the spatial coding matrix to the signals." Claims 50 and 52 are independent claims that contain similar limitations to the limitations in claim 39. The Patent Office has not cited to any portion of Agrawal that discloses determining a spatial coding matrix comprising **a respective set of spatial coding weights for each of the receivers** based on the channel state information, as recited in claim 39. Agrawal discloses matrices, but the Patent Office has not cited to any particular portion of Agrawal that teaches a spatial coding matrix comprising a respective set of spatial coding weights for each of the receivers. There is no teaching or suggestion in Agrawal that there is a respective set of spatial coding weights **for each of the receivers**. Claims 39, 50, and 52 are thus patentable over Agrawal.

Catreux and Otterseten fail to cure the deficiencies of Agrawal with respect to the independent claims.

As such, for the above reasons, Appellant requests that the Board reverse the Examiner and instruct the Examiner to allow the claims for these reasons along with the reasons noted below.

B. Legal Standards

1. For Establishing Anticipation

Section 102 of the Patent Act provides the statutory basis for an anticipation rejection and states *inter alia*:

> A person shall be entitled to a patent unless
> ***
>
> (e) the invention was described in - (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for the purposes of this subsection of an application filed in the United States only if the

> international application designated the United States and was published under Article 21(2) of such treaty in the English language. . . .

The Federal Circuit's test for anticipation has been set forth numerous times. "It is axiomatic that for prior art to anticipate under 102 it has to meet every element of the claimed invention." *Hybritech Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 1379 (Fed. Cir. 1986). This standard has been reinforced. "To anticipate a claim, a reference must disclose every element of the challenged claim and enable one skilled in the art to make the anticipating subject matter." *PPG Indus. Inc. v. Guardian Indus. Corp.*, 75 F.3d 1558, 1577 (Fed. Cir. 1996) (citations omitted). Further, "a finding of anticipation requires that the publication describe all of the elements of the claims, <u>arranged as in the patented device</u>." *C.R. Bard Inc. v. M3 Sys. Inc.*, 157 F.3d 1340, 1349 (Fed. Cir. 1998) (emphasis added and citations omitted).

2. For Establishing Obviousness

Section 103(a) of the Patent Act provides the statutory basis for an obviousness rejection and reads as follows:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Courts have interpreted 35 U.S.C. § 103(a) as a question of law based on underlying facts. As the Federal Circuit stated:

> Obviousness is ultimately a determination of law based on underlying determinations of fact. These underlying factual determinations include: (1) the scope and content of the prior art; (2) the level of ordinary skill in the art; (3) the differences between the claimed invention and the prior art; and (4) the extent of any proffered objective indicia of nonobviousness.

Monarch Knitting Mach. Corp. v. Sulzer Morat GmBH, 45 U.S.P.Q.2d (BNA) 1977, 1981 (Fed. Cir. 1998) (internal citations omitted).

Once the scope of the prior art is ascertained, the content of the prior art must be properly combined. Often, it will be necessary for a court to look to interrelated teachings of multiple patents; the effects of demand known to the design community or present in the marketplace; and

the background knowledge possessed by a person having ordinary skill in the art, all in order to determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue. To facilitate review, this analysis should be made explicit. *In re Kahn*, 441 F. 3d 977, 988 (Fed. Cir. 2006). "[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *KSR Int'l v. Teleflex, Inc.*, 550 U.S. 398, 418, 82 U.S.P.Q.2d (BNA) 1385, 1396 (2007).

While the Patent Office is entitled to give claim terms their broadest reasonable interpretation, this interpretation is limited by a number of factors. First, the interpretation must be consistent with the specification. *In re Hyatt*, 211 F.3d 1367, 1372 (Fed. Cir. 2000); M.P.E.P. § 2111. Second, the broadest reasonable interpretation of the claims must also be consistent with the interpretation that those skilled in the art would reach. Finally, the interpretation must be reasonable. *In re Cortright*, 165 F.3d 1353, 1359 (Fed. Cir. 1999); M.P.E.P. § 2111. This means that the words of the claim must be given their plain meaning unless the applicant has provided a clear definition in the specification. *In re Zletz*, 893 F.2d 319, 321 (Fed. Cir. 1989).

When rejecting a claim under § 103, the Patent Office must either show that the prior art references teach or suggest all limitations of the claim or explain why the difference(s) between the prior art and the claimed invention would have been obvious to one of ordinary skill in the art. *KSR International Co. v. Teleflex Inc.*, 550 U.S. 398, 418, 82 U.S.P.Q.2d (BNA) 1385, 1396 (2007). To establish *prima facie* obviousness, the Patent Office must show where each and every element of the claim is taught or suggested in the combination of references. *In re Royka*, 490 F.2d 981, 180 U.S.P.Q. (BNA) 580 (CCPA 1974). The gap between the prior art and the claimed invention may not be "so great as to render the [claim] nonobvious to one reasonably skilled in the art." *Dann v. Johnston*, 425 U.S. 219, 230, 189 U.S.P.Q. (BNA) 257, 261 (1976). If a claim element is missing after the combination is made, then the combination does not render obvious the claimed invention, and the claims are allowable. If the PTO fails to meet this burden, then Appellant is entitled to the patent. *In re Glaug*, 283 F.3d 1335, 1338 (Fed. Cir. 2002).

C. Claims 2-4, 6-8, 13, 15-20, 22, 26-28, 32, 34, 35, 38-43, 48-55, and 57-60 Are Not Anticipated by Agrawal

Claims 2-4, 6-8, 13, 15-20, 22, 26-28, 32, 34, 35, 38-43, 48-55, and 57-60 were rejected under 35 U.S.C. § 102(e) as being anticipated by Agrawal. Appellant respectfully traverses. For a reference to be anticipatory, the reference must disclose each and every claim element. M.P.E.P. § 2131.

1. Independent Claim 16 Is Not Anticipated By Agrawal

Agrawal fails to teach each and every element of independent claim 16. To summarize, in claim 16, the pre-coding signal weights are based on channel state information associated with the plurality of communication channels, and the decoding is done on subsets of the received weighted signals using inverses of the pre-coding signal weights based on the channel state information associated with the sub-group of the plurality of communication channels. Agrawal does not teach this method of coding and decoding, where subsets of weighted signals are decoded using inverses of the pre-coding weights that are based on channel state information of only a sub-group of the communication channels. Agrawal fails to disclose the steps of "receiving **a subset** of the weighted signals over **a sub-group of the plurality of communication channels**" and "decoding **the subset of the weighted signals** using inverses of the pre-coding signal weights **based on the channel state information associated with the sub-group of the plurality of communication channels**," at each of the receivers, as recited in claim 16.

The Patent Office alleges that Agrawal discloses receiving a subset of weighted signals over a sub-group of the plurality of communication channels in that the subset and sub-group is a number equal to or less than the total number of weighted signals and the total number of communication channels. The Patent Office also states that the signals in Agrawal are coded for transmission using the signal weights and that the receiver will conduct the opposite of the coding process to recover the signal data such that the received signals are decoded using an inverse of the encoding process (Final Office Action mailed October 13, 2009, pp. 2-4). Appellant disagrees that Agrawal discloses that **a subset** of the weighted signals over **a sub-group of the plurality of communication channels** is received at each receiver. Agrawal is silent as to subsets of weighted signals and sub-groups. Agrawal does not teach the claimed

subset of weighted signals nor the claimed sub-group of the plurality of communication channels.

The Patent Office has made no showing as to the limitations recited in claim 16 as to subsets and sub-groups and decoding the received subset of weighted signals using inverses of the pre-coding signal weights based on the channel state information associated with the sub-group of the plurality of communication channels. Agrawal does disclose a receiver for processing a received signal from an associated antenna to provide a received symbol stream (Agrawal, col. 9, lines 51-62). However, there is no teaching or suggestion that **a subset** of the weighted signals over **a sub-group of the plurality of communication channels** is received at each receiver. Agrawal is silent as to subsets of weighted signals and sub-groups. Thus, Agrawal does not teach "receiving **a subset** of the weighted signals over **a sub-group of the plurality of communication channels**" at each of the receivers, as recited in claim 16. Since Agrawal does not teach each and every element of claim 16, claim 16 is not anticipated by Agrawal.

Agrawal also does not teach "decoding **the subset of the weighted signals** using inverses of the pre-coding signal weights based on the channel state information associated **with the sub-group of the plurality of communication channels**," as recited in claim 16. The Patent Office has not pointed to any teaching in Agrawal that a subset of the weighted signals is received and decoded using inverses of the pre-coding signal weights based on the channel state information associated with the sub-group of the plurality of communication channels. Applicant finds no teaching in Agrawal of decoding **a subset** of the weighted signals, nor does Applicant find any teaching of using **inverses of the pre-coding signal weights** based on channel state information associated **with the sub-group of the plurality of communication channels**. Thus, Agrawal does not teach "decoding **the subset of the weighted signals** using inverses of the pre-coding signal weights based on the channel state information associated **with the sub-group of the plurality of communication channels**," as recited in claim 16. Claim 16 is thus patentable for this additional reason.

Moreover, what the Patent Office's position ignores is that claim 16 recites that at the receiver, a subset of the weighted signals over a sub-group of the plurality of communication channels and the subset of the weighted signals is decoded using inverses of the pre-coding signal weights **based on the channel state information associated with the sub-group of the**

plurality of communication channels. Agrawal does not disclose that the subset is decoded using inverses of the pre-coding signal weights based on channel state information **associated with the sub-group**. Instead, Agrawal discloses that the data symbol stream to be transmitted is scaled with a respective weight corresponding to the amount of transmit power allocated to that stream (Agrawal, Abstract). If, according to the Examiner's position, this symbol stream is decoded at the receiver by conducting the opposite of the coding process, then the symbols in Agrawal will be decoded using the inverse of the weight corresponding to the amount of transmit power allocated to the entire symbol stream.

Accordingly, Agrawal does not teach using the channel state information associated with a **sub-group** of the plurality of communication channels to decode a subset of the received weighted signals at the receiver. There is no indication in Agrawal that the weighted signals are divided into subsets, where a subset of the weighted signals is received over a particular sub-group of the plurality of communication channels, and the subset is then decoded using inverses of the pre-coding signal weights based on the channel state information associated with that particular sub-group. Depending on the particular sub-group and the channel state information associated with it, dividing the weighted signals into subsets, where a subset of the weighted signals is decoded using inverses of the pre-coding signal weights based on the channel state information associated with that particular sub-group, may result in a different decoding outcome. Since Agrawal does not mention dividing the weighted signals into subsets, where a subset of the weighted signals is received over a particular sub-group of the plurality of communication channels, and the subset is then decoded using inverses of the pre-coding signal weights based on the channel state information associated with that particular sub-group, Agrawal does not teach each and every element of claim 16.

Claims 2-4, 6-8, 15, and 57 depend directly or indirectly from claim 16, and are patentable based on their dependency from claim 16.

2. Independent Claim 13 Is Not Anticipated By Agrawal

Claim 13 is an independent claim that recites limitations similar to those recited in claim 16 and thus is patentable over Agrawal for at least the same reasons set forth above with respect to claim 16. Moreover, the Patent Office has not pointed with particularity to any portion of Agrawal that discloses "wherein the signals comprise respective groups of signals to be

transmitted to the receivers, wherein determining the pre-coding signal weights further comprises determining the pre-coding signal weights to separate the respective groups of signals," as recited in claim 13. Agrawal is silent as to separating the respective groups of signals by determining the pre-coding signal weights. Claim 13 is therefore patentable for this additional reason. Furthermore, the Patent Office has not pointed with particularity to any portion of Agrawal that discloses "wherein determining the pre-coding signal weights comprises determining elements of a pre-coding matrix P such that a combined communication channel matrix $C = HP$ has a form of U $N \times N$ sub-matrices, diagonal elements of which are respective diagonal elements of C, and elements of C outside the $N \times N$ sub-matrices are forced to zero," as recited in claim 13. Agrawal does not disclose U number of $N \times N$ sub-matrices. Claim 13 is therefore patentable for this additional reason.

3. Independent Claims 17, 32, and 35 Are Not Anticipated By Agrawal

Claim 17 has limitations similar to those recited in claim 16. Thus, claim 17 is also patentable over Agrawal for at least the same reasons set forth above with respect to claim 16. Claims 18-20, 22, 26-28, and 58 depend from claim 17 and include all of the limitations of claim 17. Claims 18-20, 22, 26-28, and 58 are thus patentable over Agrawal for at least the same reasons set forth above with respect to claim 17.

Independent claims 32 and 35 have similar limitations to those recited in claims 16 and 17 and are patentable for at least the same reasons as set forth with respect to claims 16 and 17.

Claims 34 and 59 depend from claim 32 and include all of the limitations of claim 32. Claims 38 and 60 depend from claim 35 and include all of the limitations of claim 35. Claims 34, 38, 59, and 60 are patentable over Agrawal based on their dependency from claims 32 or 35.

4. Independent Claims 39, 50, and 52 Are Not Anticipated By Agrawal

With respect to independent claim 39, Agrawal does not teach "determining a spatial coding matrix comprising **a respective set of spatial coding weights for each of the receivers based on the channel state information**" and "applying the respective set of spatial coding weights in the spatial coding matrix to the signals." Claim 50 is an independent claim and contains similar limitations to the limitations in claim 39. In particular, claim 50 recites "receiving from the transmitter one of a plurality of demodulation matrices for demodulating

subsequently received communication signals to which spatial coding weights comprising **respective sets of spatial coding weights for a plurality of receivers** have been applied." Claim 52 is an independent claim and contains similar limitations to the limitations in claims 39 and 50. In particular, claim 52 recites a processor configured to determine channel state information for each of a plurality of communication channels between the network element and the plurality of communication terminals, to determine a spatial coding matrix comprising **a respective set of spatial coding weights for each of the plurality of communication terminals** based on the channel state information, and to apply the respective set of spatial coding weights in the spatial coding matrix to the signals. The Patent Office has not cited to any portion of Agrawal that discloses determining a spatial coding matrix comprising **a respective set of spatial coding weights for each of the receivers** based on the channel state information, as recited in claim 39. Agrawal discloses matrices, but the Patent Office has not cited to any particular portion of Agrawal that teaches a spatial coding matrix comprising a respective set of spatial coding weights for each of the receivers. There is no teaching or suggestion in Agrawal that there is a respective set of spatial coding weights **for each of the receivers**. Claims 39, 50, and 52 are thus patentable over Agrawal.

Claims 40-43, 48, and 49 depend from claim 39 and include all of the limitations of claim 39. Claim 51 depends from claim 50 and includes all of the limitations of claim 50. Claims 53-55 depend from claim 52 and include all of the limitations of claim 52. Claims 40-43, 48, 49, 51, and 53-55 are patentable over Agrawal based on their dependency from claims 39, 50, or 52.

In addition, the Patent Office has not indicated what in Agrawal is equated to the claimed beamformers in claim 54. Accordingly, claim 54 is patentable for this additional reason.

D. Claims 10-12, 23-25, 33, 36 and 37 Are Not Obvious Over Agrawal In View Of Catreux

Claims 10-12, 23-25, 33, 36, and 37 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Agrawal in view of Catreux. To establish *prima facie* obviousness, the Patent Office must show where each and every element of the claim is taught or suggested. *In re Royka*, 490 F.2d 981, 180 U.S.P.Q. (BNA) 580 (CCPA 1974).

Claims 10-12 depend from claim 16 and contain all of the limitations of claim 16. Claims 21 and 23-25 depend from claim 17 and contain all of the limitations of claim 17. Claim

33 depends from claim 32 and contains all of the limitations of claim 32. Claims 36 and 37 depend from claim 35 and contain all of the limitations of claim 35. As set forth above, Agrawal fails to teach or suggest each and every limitation of independent claims 16, 17, 32, and 35. Thus, each of the dependent claims 10-12, 23-25, 33, 36, and 37 are patentable based on their dependency from the allowable independent claims. Catreux fails to cure the deficiencies of Agrawal in this regard. Catreux is cited merely for its disclosure of interference cancellation. Thus, claims 10-12, 23-25, 30, 33, 36, and 37 are patentable.

E. Claims 21 Is Not Obvious Over Agrawal In View Of Ottersten

Claim 21 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Agrawal in view of Ottersten. To establish *prima facie* obviousness, the Patent Office must show where each and every element of the claim is taught or suggested. M.P.E.P. § 2143.03.

Claim 21 depends from claim 17 and contains all of the limitations of claim 17. Thus, dependent claim 21 is patentable based on its dependency from the allowable independent claim 17. As set forth above, Agrawal fails to teach or suggest each and every limitation of independent claim 17. Ottersten fails to cure the deficiencies of Agrawal in this regard. Ottersten is cited merely for its disclosure of the Moore-Penrose pseudo-inverse matrix. Thus, claim 21 is patentable.

F. Conclusion

As set forth above, the Patent Office has not made the necessary showing that all the elements of the pending claims are found in the prior art with sufficient particularity in order to sustain an anticipation or obviousness rejection. In particular, Agrawal fails to teach or suggest each and every element of independent claim 16. To summarize, in claim 16, the pre-coding signal weights are based on channel state information associated with the plurality of communication channels, and the decoding is done on subsets of the received weighted signals using inverses of the pre-coding signal weights based on the channel state information associated with the sub-group of the plurality of communication channels. Agrawal does not teach this method of coding and decoding, where subsets of weighted signals are decoded using inverses of the pre-coding weights that are based on channel state information of only a sub-group of the communication channels. Agrawal fails to disclose the steps of "receiving **a subset** of the

weighted signals over **a sub-group of the plurality of communication channels**" and "decoding **the subset of the weighted signals** using inverses of the pre-coding signal weights **based on the channel state information associated with the sub-group of the plurality of communication channels**," at each of the receivers, as recited in claim 16.

Claim 13 is an independent claim that recites limitations similar to those recited in claim 16 and thus is patentable over Agrawal for at least the same reasons set forth above with respect to claim 16. Moreover, the Patent Office has not pointed with particularity to any portion of Agrawal that discloses "wherein the signals comprise respective groups of signals to be transmitted to the receivers, wherein determining the pre-coding signal weights further comprises determining the pre-coding signal weights to separate the respective groups of signals," as recited in claim 13. Agrawal is silent as to separating the respective groups of signals by determining the pre-coding signal weights. Furthermore, the Patent Office has not pointed with particularity to any portion of Agrawal that discloses "wherein determining the pre-coding signal weights comprises determining elements of a pre-coding matrix P such that a combined communication channel matrix $C = HP$ has a form of U $N \times N$ sub-matrices, diagonal elements of which are respective diagonal elements of C, and elements of C outside the $N \times N$ sub-matrices are forced to zero," as recited in claim 13.

Claim 17 has limitations similar to those recited in claim 16. Independent claims 32 and 35 have similar limitations to those recited in claims 16 and 17. Thus, independent claims 17, 32, and 35 are patentable for at least the same reasons as set forth with respect to claim 16.

With respect to independent claim 39, Agrawal does not teach "determining a spatial coding matrix comprising **a respective set of spatial coding weights for each of the receivers based on the channel state information**" and "applying the respective set of spatial coding weights in the spatial coding matrix to the signals." Claims 50 and 52 are independent claim that contain similar limitations to the limitations in claim 39. The Patent Office has not cited to any portion of Agrawal that discloses determining a spatial coding matrix comprising **a respective set of spatial coding weights for each of the receivers** based on the channel state information, as recited in claim 39. Agrawal discloses matrices, but the Patent Office has not cited to any particular portion of Agrawal that teaches a spatial coding matrix comprising a respective set of spatial coding weights for each of the receivers. There is no teaching or suggestion in Agrawal

that there is a respective set of spatial coding weights **for each of the receivers**. Claims 39, 50, and 52 are thus patentable over Agrawal.

Catreux and Otterseten fail to cure the deficiencies of Agrawal with respect to the independent claims.

As such, for the above reasons, Appellant requests that the Board reverse the Examiner and instruct the Examiner to allow claims 2-4, 6-28, 32-43, 44-55, 57-60.

Respectfully submitted,

WITHROW & TERRANOVA, P.L.L.C.

By: John R. Witcher, III

John R. Witcher, III
Registration No. 39,877
100 Regency Forest Drive, Suite 160
Cary, NC 27518
Telephone: (919) 238-2300

Date: September 7, 2010
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(8) CLAIMS APPENDIX

1. (Cancelled).

2. The method of claim 16, further comprising receiving the channel state information from the receivers.

3. The method of claim 16, wherein the pre-coding signal weights are elements of a pre-coding matrix P, and wherein determining further comprises determining the pre-coding signal weights to enhance diagonal elements of a combined communication channel matrix $C = HP$, where H is a matrix of the channel state information.

4. The method of claim 3, wherein determining the pre-coding signal weights to enhance the diagonal elements comprises determining the pre-coding signal weights to maximize the diagonal elements of C, and wherein determining the pre-coding signal weights further comprises determining the pre-coding signal weights to force off-diagonal elements of C to zero.

5. A method of processing signals to be transmitted to receivers on a plurality of communication channels, comprising:

determining pre-coding signal weights based on channel state information associated with the plurality of communication channels to provide proportional power allocation to the signals; and

applying the pre-coding signal weights to the signals,

wherein the pre-coding signal weights are elements of a pre-coding matrix P,

wherein determining further comprises determining the pre-coding signal weights to enhance diagonal elements of a combined communication channel matrix $C = HP$, where H is a matrix of the channel state information; and

wherein $P = \begin{bmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{bmatrix}$, wherein $H = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix}$, and wherein determining comprises selecting the pre-coding signal weights of P such that

$$|p_{11}| \propto \left| h_{11} - \frac{h_{12}h_{21}}{h_{22}} \right|;$$

$$|p_{22}| \propto \left| h_{22} - \frac{h_{12}h_{21}}{h_{11}} \right|;$$

$$p_{12} = -\frac{h_{12}p_{22}}{h_{11}}; \text{ and}$$

$$p_{21} = -\frac{h_{21}p_{11}}{h_{22}}.$$

6. The method of claim 3, implemented in a transmitter having M antennas comprising sub-groups of antennas respectively associated with the sub-groups of the plurality of communication channels, wherein C comprises a plurality of groups of rows respectively associated with the sub-groups of the plurality of communication channels and a plurality of groups of columns respectively associated with the sub-groups of antennas, and wherein determining the pre-coding signal weights further comprises determining the pre-coding signal weights to force each element of C positioned in a row associated with one of the sub-groups of the plurality of communication channels and a column associated with the sub-group of antennas that is associated with a different one of the sub-groups of the plurality of communication channels to zero.

7. The method of claim 6, wherein the sub-groups of the plurality of communication channels comprise U sub-groups each having N communication channels, wherein $M = U * N$, wherein the sub-groups of antennas comprise M / U sub-groups each having N antennas, wherein each of the plurality of groups of rows comprises N rows, and wherein each of the plurality of groups of columns comprises N columns.

8. The method of claim 6, wherein the sub-groups of the plurality of communication channels comprise U sub-groups, an ith sub-group of the plurality of communication channels having N_i communication channels, wherein $M = \sum_{i=1}^{U} N_i$, wherein the sub-groups of antennas

comprise M/U sub-groups, wherein an i th sub-group of antennas comprises N_i antennas, wherein an i th group of rows of the plurality of groups of rows comprises N_i rows, and wherein an i th group of columns of the plurality of groups of columns comprises N_i columns.

9. The method of claim 7, wherein M =4, N =2, U =2, and wherein determining the pre-coding signal weights comprises selecting the pre-coding signal weights of P such that

$$C = HP = \begin{bmatrix} c_{11} & c_{12} & 0 & 0 \\ c_{21} & c_{22} & 0 & 0 \\ 0 & 0 & c_{33} & c_{34} \\ 0 & 0 & c_{43} & c_{44} \end{bmatrix},$$

where a group of the first two rows of C is associated with a first of two sub-groups of the plurality of communication channels, a group of the third and fourth rows of C is associated with a second of the two sub-groups of the plurality of communication channels, a group of the first two columns of C is associated with a first of two sub-groups of two antennas, and a group of the third and fourth columns of C is associated with a second of the two sub-groups of two antennas.

10. The method of claim 16, wherein applying the pre-coding signal weights comprises a first interference cancellation operation of an interference cancellation task, and wherein the interference cancellation task further comprises a second interference cancellation task to be performed at the receivers.

11. The method of claim 10, wherein the signals comprise respective groups of signals to be transmitted to the receivers, wherein determining the pre-coding signal weights further comprises determining the pre-coding signal weights to separate the respective groups of signals.

12. The method of claim 11, implemented at a transmitter in a multi-user MIMO (Multiple Input Multiple Output) communication system that provides respective $N \times N$ sub-MIMO channels from the transmitter to the receivers, wherein each of the respective groups of signals comprises N signals.

13. A method of processing signals to be transmitted to receivers on a plurality of communication channels, comprising:

determining pre-coding signal weights based on channel state information associated with the plurality of communication channels to provide proportional power allocation to the signals; and

applying the pre-coding signal weights to the signals,

wherein the method is implemented at a transmitter in a multi-user MIMO (Multiple Input Multiple Output) communication system that provides respective $N \times N$ sub-MIMO channels from the transmitter to the receivers, wherein each of the groups of signals comprises N signals,

wherein the signals comprise respective groups of signals to be transmitted to the receivers, wherein determining the pre-coding signal weights further comprises determining the pre-coding signal weights to separate the respective groups of signals, and

wherein determining the pre-coding signal weights comprises determining elements of a pre-coding matrix P such that a combined communication channel matrix $C = HP$ has a form of U $N \times N$ sub-matrices, diagonal elements of which are respective diagonal elements of C, and elements of C outside the $N \times N$ sub-matrices are forced to zero.

14. The method of claim 13, wherein the transmitter has M =4 antennas, wherein U =2,

$$N=2,\ P=\begin{bmatrix} p_{11} & p_{12} & p_{13} & p_{14} \\ p_{21} & p_{22} & p_{23} & p_{24} \\ p_{31} & p_{32} & p_{33} & p_{34} \\ p_{41} & p_{42} & p_{43} & p_{44} \end{bmatrix},\ H=\begin{bmatrix} h_{11} & h_{12} & h_{13} & h_{14} \\ h_{21} & h_{22} & h_{23} & h_{24} \\ h_{31} & h_{32} & h_{33} & h_{34} \\ h_{41} & h_{42} & h_{43} & h_{44} \end{bmatrix},\ C=HP=\begin{bmatrix} c_{11} & c_{12} & 0 & 0 \\ c_{21} & c_{22} & 0 & 0 \\ 0 & 0 & c_{33} & c_{34} \\ 0 & 0 & c_{43} & c_{44} \end{bmatrix},$$

wherein determining elements of P comprises:

selecting p_{31}, p_{41}, p_{32}, and p_{42} to force $c_{13} = c_{14} = c_{23} = c_{24}$ =0;

selecting $\begin{cases} p_{11} = va_{11}^{*} \\ p_{21} = va_{12}^{*} \\ p_{12} = va_{21}^{*} \\ p_{22} = va_{22}^{*} \end{cases}$, where v is a power normalization factor and a_{ij} are elements of A, where $A = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} - \frac{1}{\Delta}\begin{bmatrix} h_{13} & h_{14} \\ h_{23} & h_{24} \end{bmatrix}\begin{bmatrix} h_{44} & -h_{34} \\ -h_{43} & h_{33} \end{bmatrix}\begin{bmatrix} h_{31} & h_{32} \\ h_{41} & h_{42} \end{bmatrix}$ and $\Delta = h_{33}h_{44} - h_{34}h_{43}$;

selecting p_{13}, p_{23}, p_{14}, and p_{24} to force $c_{31} = c_{32} = c_{41} = c_{42} = 0$; and

selecting $\begin{cases} p_{33} = va_{11}^{*} \\ p_{43} = va_{12}^{*} \\ p_{34} = va_{21}^{*} \\ p_{44} = va_{22}^{*} \end{cases}$, where a_{ij} are elements of A, where

$A = \begin{bmatrix} h_{33} & h_{34} \\ h_{43} & h_{44} \end{bmatrix} - \frac{1}{\Delta}\begin{bmatrix} h_{31} & h_{32} \\ h_{41} & h_{42} \end{bmatrix}\begin{bmatrix} h_{22} & -h_{12} \\ -h_{21} & h_{11} \end{bmatrix}\begin{bmatrix} h_{13} & h_{14} \\ h_{14} & h_{24} \end{bmatrix}$, and $\Delta = h_{11}h_{22} - h_{12}h_{21}$.

15. (Currently Amended) A computer program product comprising a computer-readable medium storing instructions which, when executed by a processor, perform the method of claim 16.

16. A method of processing signals to be transmitted to receivers on a plurality of communication channels, comprising:

determining pre-coding signal weights based on channel state information associated with the plurality of communication channels to provide proportional power allocation to the signals;

applying the pre-coding signal weights to the signals;

transmitting weighted signals to the receivers on the plurality of communication channels; and

at each of the receivers:

receiving a subset of the weighted signals over a sub-group of the plurality of communication channels; and

decoding the subset of the weighted signals using inverses of the pre-coding signal weights based on the channel state information associated with the sub-group of the plurality of communication channels.

17. A method comprising:

receiving over a sub-group of a plurality of communication channels a subset of a plurality of signals to which pre-coding signal weights based on channel state information associated with the sub-group of the plurality of communication channels to provide proportional power allocation have been applied; and

decoding the subset of the plurality of signals using inverses of the pre-coding signal weights based on the channel state information associated with the sub-group of the plurality of communication channels.

18. The method of claim 17, further comprising:

determining the channel state information for the sub-group of the plurality of communication channels.

19. The method of claim 18, wherein receiving the subset of the plurality of signals comprises receiving the subset of the plurality of signals from a transmitter, further comprising:

transmitting the channel state information for the sub-group of the plurality of communication channels to the transmitter.

20. The method of claim 17, wherein the pre-coding signal weights are elements of a pre-coding matrix P determined to enhance diagonal elements of a combined communication channel matrix $C = HP$, where H is a matrix of the channel state information associated with the sub-group of the plurality of communication channels, and wherein decoding comprises decoding the subset of the plurality of signals using an inverse of either P or C.

21. The method of claim 20, wherein the inverse is a Moore-Penrose pseudo-inverse matrix.

22. The method of claim 17, wherein receiving the subset of the plurality of signals comprises receiving the subset of the plurality of signals at respective antennas.

23. The method of claim 17, wherein the pre-coding weights separate the plurality of signals into subsets comprising the subset of the plurality of signals as a first interference cancellation operation, and wherein decoding comprises performing a further interference cancellation operation.

24. The method of claim 23, wherein decoding comprises ML (Maximum Likelihood) decoding.

25. The method of claim 23, wherein performing the further interference cancellation operation comprises separating individual signals from the subset of the plurality of signals.

26. The method of claim 17, implemented at a receiver in a multi-user MIMO (Multiple Input Multiple Output) communication system that provides an $N \times N$ sub-MIMO channel to the receiver, wherein the subset of the plurality of signals comprises N signals.

27. The method of claim 26, wherein the pre-coding signal weights are elements of a pre-coding matrix P determined such that a combined communication channel matrix $C = HP$ has a form of U $N \times N$ sub-matrices, and wherein decoding comprises decoding the subset of the plurality of signals using an inverse of one of the U $N \times N$ sub-matrices.

28. A computer program product comprising a computer-readable medium storing instructions which, when executed by a processor, perform the method of claim 17.

29. (Cancelled).

30. (Cancelled).

31. (Cancelled).

32. A system for processing signals to be transmitted to receivers on a plurality of communication channels comprising:

an input means for receiving the signals; and

a processor configured to determine pre-coding signal weights based on channel state information associated with the plurality of communication channels to provide proportional power allocation to the signals, and to apply the pre-coding signal weights to the signals,

wherein the system is implemented at a network element of a communication network, the communication network further comprising a plurality of receivers, each receiver of the plurality of receivers comprising:

an input means for receiving a subset of weighted signals over a sub-group of the plurality of communication channels; and

a processor configured to decode the subset of weighted signals using inverses of the pre-coding signal weights based on the channel state information associated with the sub-group of the plurality of communication channels.

33. The system of claim 32, wherein the communication network is selected from [[the]] a group consisting of: a MIMO (Multiple Input Multiple Output) system and a MIMO BLAST system.

34. The system of claim 32, wherein the processor of each receiver of the plurality of receivers is further configured to determine and feed back to the network element a portion of the channel state information.

35. A system comprising:

an input means for receiving over a sub-group of a plurality of communication channels a subset of a plurality of signals to which pre-coding signal weights based on channel state information associated with the sub-group of the plurality of communication channels to provide proportional power allocation have been applied; and

a processor configured to decode the subset of the plurality of signals using inverses of the pre-coding signal weights based on the channel state information associated with the sub-group of the plurality of communication channels.

36. The system of claim 35, wherein the processor implements an ML (Maximum Likelihood) decoder.

37. The system of claim 35, wherein the processor is further configured to cancel interference between each signal in the subset of the plurality of signals.

38. The system of claim 35, implemented in a MIMO (Multiple Input Multiple Output) communication system, further comprising:

a plurality of antennas,

wherein the plurality of antennas provides a sub-MIMO communication channel comprising the sub-group of the plurality of communication channels.

39. A method of processing signals to be concurrently transmitted to receivers over a plurality of communication channels comprising:

determining channel state information for the plurality of communication channels;

determining a spatial coding matrix comprising a respective set of spatial coding weights for each of the receivers based on the channel state information; and

applying the respective set of spatial coding weights in the spatial coding matrix to the signals.

40. The method of claim 39, wherein the signals comprise a plurality of groups of at least one signal to be transmitted to respective ones of the receivers.

41. The method of claim 40, wherein the plurality of groups of at least one signal comprises groups of signals comprising different numbers of signals.

42. The method of claim 39, wherein determining the channel state information comprises:

receiving portions of the channel state information from the receivers; and

combining the portions of the channel state information to form the channel state information.

43. The method of claim 40, further comprising:

transmitting the signals to the receivers,

wherein the spatial coding matrix F comprises elements $[F^{(1)}, F^{(2)}, \ldots F^{(U)}]$, U an integer, where each element $F^{(i)}$ is the respective set of spatial coding weights for an i^{th} one of the receivers and satisfies $tr\{F^{(i)} F^{(i)'}\} = tr\{F^{(i)'} F^{(i)}\} = P_s$, $i = 1, 2, .., U$, where $tr\{\bullet\}$ is [[the]] a trace of a matrix, and P_s is a total transmitted power of the signals.

44. The method of claim 43, implemented in a MIMO (Multiple Input Multiple Output) communication system, wherein determining a spatial coding matrix comprises determining the elements $F^{(i)}$ of F as

$$F^{(i)} = \sqrt{P_s} \frac{\hat{G}^{(i)'}}{\sqrt{tr(\hat{G}^{(i)'} \hat{G}^{(i)})}},$$

where

$\hat{G}^{(i)} = \hat{H}_F^{(i)'} (\hat{H}_F \hat{H}_F' + I_{N_t})^{-1}$, $i = 1, 2, \ldots U$, is a set of [[the]] demodulation weights corresponding to $F^{(i)}$;

$\hat{H}_F = [\hat{H}_F^{(1)}, \ldots \hat{H}_F^{(U)}]$;

$\hat{H}_F^{(i)} = (\hat{H}^{(i)} \hat{F}^{(i)}) / \sqrt{2\sigma_{\eta,i}^{2}}$ is a combined channel matrix of a virtual reverse MIMO channel from the ith receiver;

$\hat{H}^{(i)} = [H^{(i)}]'$ is a matrix of the channel state information of the virtual reverse MIMO channel from the ith receiver;

$H^{(i)}$ is a matrix of the channel state information for a forward MIMO channel of [[the]] a plurality of channels to the ith receiver;

$\hat{F}^{(i)}$ is a spatial coding matrix of the virtual reverse MIMO channel from the ith receiver;

I_{N_i} is a unit matrix;

N_i is a number of signals in the plurality of groups of at least one signal to be transmitted to the ith receiver; and

$\sigma_{\eta,i}^{2}$ is a variance of a component of noise at the ith receiver.

45. The method of claim 44, further comprising:

transmitting a respective set of demodulation weights $\hat{G}^{(i)}$ to each of the receivers.

46. The method of claim 44, wherein $\hat{F}^{(i)} = \overline{V}^{(i)}\Phi^{(i)}$

where

$\overline{V}^{(i)}$ is a matrix constructed from columns of $V^{(i)}$;

$V^{(i)}$ is a unitary matrix resulting from the singular decomposition of a channel matrix $H^{(i)}$ of a MIMO channel to the ith receiver as $\widetilde{H}^{(i)} = U^{(i)}\Lambda^{(i)}V^{(i)^H}$, where $U^{(i)}$ and $V^{(i)}$ are unitary matrices, $\Lambda^{(i)}$ is a non-negative diagonal matrix, squares of diagonal elements of $\Lambda^{(i)}$ are equal to eigenvalues of an $\hat{H}^{(i)}\hat{H}^{(i)'}$ matrix, columns of $U^{(i)}$ are eigenvectors of the $\hat{H}^{(i)}\hat{H}^{(i)'}$ matrix, and [[the]] columns of $V^{(i)}$ are also eigenvectors of the $\hat{H}^{(i)}\hat{H}^{(i)'}$ matrix; and

$\Phi^{(i)}$ is a diagonal matrix having non-negative diagonal elements that determine channel power allocation and satisfy $tr(\hat{F}^{(i)}\hat{F}^{(i)'}) = \sum_{k=1}^{K_{ch,i}} {\phi^{(i)}}_{k,k}^{2} = P_s$, where $K_{ch,i}$ is a number of spatial channels to the ith receiver.

47. The method of claim 46, wherein the diagonal elements of $\Phi^{(i)}$ are selected according to a criterion selected from a group consisting of:

a uniform power criterion, ${\phi^{(i)}}_{k,k}^{2} = P_s / K_{ch,i}$;

an MMSE (Maximum Mean Squared Error) criterion,

$${\phi^{(i)}}_{k,k}^{2} = 2\sigma_{\eta,i}^{2}\left[\frac{\mu}{\sqrt{{\xi^{(i)}}_{k,k}}} - \frac{1}{{\xi^{(i)}}_{k,k}}\right]^{+};$$

an MSER (Minimum Symbol-Error-Rate) criterion, $\phi^{(i)}{}_{k,k}{}^2 = \frac{2\sigma_{\eta,i}{}^2}{\xi^{(i)}{}_{k,k}}\left[\log\left(\frac{\xi^{(i)}{}_{k,k}}{2\sigma_{\eta,i}{}^2}\right) - \mu\right]^+$;

and

an MCIR (Maximum Capacity and Information Rate) criterion, $\phi^{(i)}{}_{k,k}{}^2 = \left(\mu - \frac{2\sigma_{\eta,i}{}^2}{\xi^{(i)}{}_{k,k}}\right)^+$,

where

$(\bullet)^+ = \max(\bullet,0) = \frac{1}{2}(|\bullet| + \bullet)$;

$\xi^{(i)}{}_{k,k} = \lambda^{(i)}{}_{k,k}{}^2$ are eigenvalues of the $\hat{H}^{(i)}\hat{H}^{(i)\prime}$ matrix, and $\lambda^{(i)}{}_{k,k}$ are diagonal elements of the $\Lambda^{(i)}$ matrix; and

μ is a factor selected to define the MMSE, MSER, and MCIR criteria.

48. A computer program product comprising a computer-readable medium storing instructions which, when executed by a processor, perform the method of claim 39.

49. The method of claim 39, further comprising:

determining a plurality of demodulation matrices respectively corresponding to the respective set of spatial coding weights;

transmitting the plurality of demodulation matrices from a transmitter to the receivers;

transmitting weighted signals to the receivers over the plurality of communication channels; and

at each of a plurality of receivers:

receiving the weighted signals and the plurality of demodulation matrices;

determining the channel state information for a communication channel between the receiver and the transmitter; and

transmitting the channel state information to the transmitter.

50. A method comprising:

determining channel state information for a communication channel between a receiver and a transmitter;

transmitting the channel state information to the transmitter; and

receiving from the transmitter one of a plurality of demodulation matrices for demodulating subsequently received communication signals to which spatial coding weights comprising respective sets of spatial coding weights for a plurality of receivers have been applied.

51. A computer program product comprising a computer-readable medium storing instructions which, when executed by a processor, perform the method of claim 50.

52. A network element for processing signals to be concurrently transmitted to a plurality of communication terminals in a communication network, comprising:

an input means configured to receive the signals; and

a processor configured to determine channel state information for each of a plurality of communication channels between the network element and the plurality of communication terminals, to determine a spatial coding matrix comprising a respective set of spatial coding weights for each of the plurality of communication terminals based on the channel state information, and to apply the respective set of spatial coding weights in the spatial coding matrix to the signals.

53. The network element of claim 52, wherein the input means is further configured to receive portions of the channel state information from the plurality of communication terminals, and wherein the processor is further configured to combine the portions of the channel state information to thereby determine the channel state information.

54. The network element of claim 53, wherein the signals comprise respective groups of signals to be transmitted to the plurality of communication terminals, and wherein the processor implements a plurality of beamformers, each beamformer of the plurality of beamformers being configured to apply the respective sets of spatial coding weights to respective ones of the groups of the signals.

55. The network element of claim 52, implemented in a closed-loop multi-user MIMO (Multiple Input Multiple Output) communication system, wherein the processor of the network element is further configured to determine a respective demodulation matrix corresponding to each respective set of spatial coding weights, the network element further comprising:

a plurality of antennas for transmitting the respective demodulation matrix and weighted signals to the plurality of communication terminals,

wherein the closed-loop multi-user MIMO communication system further comprises the plurality of communication terminals, each of the plurality of communication terminals comprising:

a processor configured to determine the channel state information for communication channels of the plurality of communication channels between a communication terminal of the plurality of communication terminals and the network element; and

at least one antenna for transmitting the channel state information from the communication terminal to the network element, receiving the respective demodulation matrix from the network element, and receiving the weighted signals from the network element,

wherein the processor of the communication terminal is further configured to demodulate the received weighted signals using the respective demodulation matrix.

56. (Cancelled).

57. The method of claim 16, wherein the transmitting step further comprises transmitting the weighted signals to the receivers from a transmitter having M antennas comprising U sub-groups of antennas, each antenna of the U sub-groups of antennas respectively associated with a corresponding subgroup of the plurality of communication channels, each of the U sub-groups of antennas having N communication channels, and wherein M is equal to or greater than 4, U is equal to or greater than 2, and N is equal to or greater than 2.

58. The method of claim 17, wherein the receiving step further comprises receiving the subset of the plurality of signals from a transmitter having M antennas comprising U sub-groups of antennas, each antenna of the U sub-groups of antennas respectively associated with a corresponding sub-group of the plurality of communication channels, each of the U sub-groups

of antennas having N communication channels, and wherein M is equal to or greater than 4, U is equal to or greater than 2, and N is equal to or greater than 2.

59. The system of claim 32, further comprising a transmitter for transmitting the subset of weighted signal, wherein the transmitter has M antennas comprising U sub-groups of antennas, each antenna of the U sub-groups of antennas respectively associated with a corresponding sub-group of the plurality of communication channels, each of the U sub-groups of antennas having N communication channels, and wherein M is equal to or greater than 4, U is equal to or greater than 2, and N is equal to or greater than 2.

60. The system of claim 35 further comprising a transmitter having M antennas comprising U sub-groups of antennas, each antenna of the U sub-groups of antennas respectively associated with a corresponding sub-group of the plurality of communication channels, each of the U sub-groups of antennas having N communication channels, and wherein M is equal to or greater than 4, U is equal to or greater than 2, and N is equal to or greater than 2, wherein the subset of the plurality of signals is received from the transmitter.

(9) EVIDENCE APPENDIX

Appellant relies on no evidence, thus this appendix is not applicable.

(10) RELATED PROCEEDINGS APPENDIX

As there are no related proceedings, this appendix is not applicable.